DUDLEY KNOX LIBRARY
NAVAL POSTGRADUATE SCHOOL
MONTEREY, CALIFORNIA 93943

NPS554-85-011

NAVAL POSTGRADUATE SCHOOL
Monterey, California

THESIS

AN ANALYSIS OF S-3 SDLM CORROSION DOCUMENTATION PROCEDURES

by

Steven Louis Hanson

and

Mark Evan Karr

December 1985

Thesis Advisors: John W. Creighton
Casimir E. Lawler

Approved for public release; distribution unlimited.

Prepared for:
Naval Air Rework Facility
Alameda, California 94501-5021

T226329

NAVAL POSTGRADUATE SCHOOL
Monterey, CA 93943-5100

Rear Admiral R. H. Shumaker
Superintendent

D. A. Schrady
Provost

This thesis prepared in conjunction with research sponsored in part by Naval Air Rework Facility, Naval Air Station, Alameda under N63126-85-WR10303.

Reproduction of all or part of this report is authorized.

Released by:

UNCLASSIFIED
URITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

REPORT SECURITY CLASSIFICATION	1b. RESTRICTIVE MARKINGS
SECURITY CLASSIFICATION AUTHORITY	3. DISTRIBUTION / AVAILABILITY OF REPORT Approved for public release; distribution unlimited.
DECLASSIFICATION / DOWNGRADING SCHEDULE	
ERFORMING ORGANIZATION REPORT NUMBER(S) PS Report No. NP554-85-011	5. MONITORING ORGANIZATION REPORT NUMBER(S)
NAME OF PERFORMING ORGANIZATION aval Postgraduate School 6b. OFFICE SYMBOL (If applicable) Code 54	7a. NAME OF MONITORING ORGANIZATION Naval Postgraduate School
ADDRESS (City, State, and ZIP Code) onterey, California 93943-5100	7b. ADDRESS (City, State, and ZIP Code) Monterey, California 93943-5100
NAME OF FUNDING / SPONSORING ORGANIZATION aval Air Rework Facility lameda, CA 8b. OFFICE SYMBOL (If applicable) Code 310	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
ADDRESS (City, State, and ZIP Code) aval Air Station Lameda, California 94501-5021	10. SOURCE OF FUNDING NUMBERS PROGRAM ELEMENT NO. / PROJECT NO. / TASK NO. / WORK UNIT ACCESSION NO. N63126-85-WR10303

TITLE (Include Security Classification)
N ANALYSIS OF S-3 SDLM CORROSION DOCUMENTATION PROCEDURES

PERSONAL AUTHOR(S)
anson, Steven L. and Karr, Mark E.

TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT (Year, Month, Day)	15. PAGE COUNT
aster's Thesis	FROM _____ TO _____	December 1985	77

SUPPLEMENTARY NOTATION

COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
FIELD	GROUP	SUB-GROUP	Information Systems; Aviation Maintenance; Corrosion Rework; 3M reporting; Maintenance Requirement; Preventive Maintenance

ABSTRACT (Continue on reverse if necessary and identify by block number)

When senior personnel in Naval aviation are asked the question, "How uch time and money are we spending on corrosion prevention and correction?", airly accurate estimates can be obtained for the organizational and intermediate levels of maintenance because they break out these costs in their aintenance data reporting system. It is virtually impossible to quantify hese same costs at the depot level since their current reporting system ill not allow for the collection of such information. A second problem, aused by this rather limited reporting system, concerns the inability of he depot level engineering staff to gather sufficient accurate information bout the types, extent, and locations of corrosion that occur on aircraft.

DISTRIBUTION / AVAILABILITY OF ABSTRACT ☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT ☐ DTIC USERS	21. ABSTRACT SECURITY CLASSIFICATION UNCLASSIFIED
NAME OF RESPONSIBLE INDIVIDUAL ohn W. Creighton	22b TELEPHONE (Include Area Code) (408) 646-2048 22c. OFFICE SYMBOL Code 54 Cf

FORM 1473, 84 MAR 83 APR edition may be used until exhausted
All other editions are obsolete.

SECURITY CLASSIFICATION OF THIS PAGE

UNCLASSIFIED

This report provides a system design and implementation plan for corrosion monitoring for the Naval Air Rework Facility at Alameda, California.

Approved for public release; distribution unlimited.

An Analysis of S-3 SDLM Corrosion Documentation Procedures

by

Steven Louis Hanson
Lieutenant Commander, United States Navy
B.S., Iowa State University, 1976

and

Mark Evan Karr
Lieutenant, United States Navy
B.S., North Carolina State University, 1978

Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN MANAGEMENT

from the

NAVAL POSTGRADUATE SCHOOL
December 1985

ABSTRACT

When senior personnel in Naval aviation are asked the question, "How much time and money are we spending on corrosion prevention and correction?", fairly accurate estimates can be obtained for the organizational and intermediate levels of maintenance because they break out these costs in their maintenance data reporting systems. It is virtually impossible to quantify these same costs at the depot level since their current reporting system will not allow for the collection of such information. A second problem, caused by this rather limited reporting system, concerns the inability of the depot level engineering staff to gather sufficient accurate information about the types, extent, and locations of corrosion that occur on aircraft.

This report provides a system design and implementation plan for corrosion monitoring for the Naval Air Rework Facility at Alameda, California.

EXECUTIVE SUMMARY

Accurate documentation of corrosion prevention/control costs and the components that undergo the work is essential to the continued proper operation of today's complex and costly airborne weapon systems. The NESO S-3 Engineering Division Head at NARF Alameda recognized that such information was not being collected about the S-3 aircraft undergoing rework, and requested that we study the situation and recommend a course of action.

Current NARF Alameda corrosion documentation is sufficient to ensure that discovered discrepancies are corrected. It is wholly insufficient for computer entry and is not readily suited to today's accepted methods of management or engineering analysis.

Realization of these facts leads us to the obvious conclusion; a computerized system for corrosion data collection and processing is needed. Our research in this area led us to the Depot Maintenance Data System (DMDS). The implementation of DMDS at NARF Alameda was scheduled for April 1982, but hardware installation and software activation were the only steps of the system implementation process that had been accomplished until this system was identified to NESO in early 1985. The engineering organization is attempting to complete system

implementation, but the cooperation and strong support of NARF management and staff is needed to ensure success.

Although implementation of this information gathering system will not provide all of the desired data, it promises to provide numerous benefits. Some of these are:

1. Closing the maintenance information loop between the organizational, intermediate, and depot levels.
2. Provision of computerized maintenance information so modern analysis techniques can be used.
3. Improving NARF's capability to justify, document, and validate maintenance requirements at all three levels of maintenance.
4. Enabling engineering to identify systems and components that exhibit various types and degrees of corrosion damage.
5. Provision of quantitative inputs to logistics planning for new weapon systems and equipment.
6. A decrease in the overall costs of production.

One of the shortfalls of the DMDS concerns its inability to gather sufficiently specific information about the location of corrosion on a particular component or section of structure. The structurally significant item inspections that are conducted as part of the NARF Structural Sampling Program can provide much of this information. For this reason, we additionally recommend specific areas of the Structural Sampling Program that are in need of review/ amendment.

TABLE OF CONTENTS

I. INTRODUCTION ---------- 11

A. PROBLEM DEFINITION ---------- 13

B. RESEARCH METHODOLOGY ---------- 15

II. CURRENT REQUIREMENTS AND PROCEDURES ---------- 17

A. REVIEW OF DIRECTIVES ---------- 17

B. IN-PRACTICE DOCUMENTATION PROCEDURES --------- 19

C. ANALYSIS OF REQUIRED AND ACTUAL PROCEDURES --- 25

III. CURRENT DOCUMENTATION USES ---------- 28

A. DATA ENTRY ---------- 28

B. CURRENT USES OF CORROSION DOCUMENTATION ------ 30

C. ADDITIONAL DESIRED USES OF CORROSION DOCUMENTATION ---------- 32

IV. DATA COLLECTION ALTERNATIVES ---------- 35

A. DMDS DESCRIPTION ---------- 36

B. GENERAL IMPLEMENTATION PLAN ---------- 39

C. DMDS BENEFITS ---------- 41

D. SHORTCOMINGS AND PROBLEMS ---------- 42

V. RECOMMENDATIONS AND COMMENTS ---------- 44

A. THE SSI PROGRAM ---------- 44

B. THE DEPOT MAINTENANCE DATA SYSTEM (DMDS) ----- 46

C. GENERAL COMMENTS ---------- 50

APPENDIX A: SSI PROGRAM ORGANIZATIONAL COMPONENTS AND RESPONSIBILITIES ---------- 54

APPENDIX B: S-3 SDLM PROCESS STEPS ---------- 56

APPENDIX C: SSI PROGRAM DISCREPANCIES ---------- 57

APPENDIX D: MATERIAL CONTROL SYSTEM APPLICATIONS ------ 58

APPENDIX E: FINANCIAL CONTROL SYSTEM APPLICATIONS ----- 59

APPENDIX F: WORKLOAD CONTROL SYSTEM APPLICATIONS ------ 61

APPENDIX G: DMDS DATA ELEMENTS ---------- 65

LIST OF REFERENCES ---------- 72

INITIAL DISTRIBUTION LIST ---------- 74

LIST OF ACRONYMS

BUNO	Bureau Number
CIN	Component Identity Number
CTC	Corrosion Type Code
DMDS	Depot Maintenance Data System
EDR	Equipment Data Record
EOC	Extent of Corrosion
E&E	Examination and Evaluation
F/E	Fleet Equipment
GSE	Ground Support Equipment
ICC	Incoming Condition Code
IPB	Illustrated Parts Breakdown
MAL	Malfunction Code
MC	Meter Code
MDR	Master Data Record
MDRCC	MDR Control Code
MH	Man-Hour
MHC	Man-Hour Category Code
MIS	Management Information System
MIS/INAS	Management Information System for Industrial Naval and Marine Corps Air Station
NALC	Naval Aviation Logistics Center
NALDA	Naval Aviation Logistics Data Analysis
NAMSO	Naval Aviation Maintenance Support Office
NARDAC	Naval Regional Data Automation Center

NARF	Naval Air Rework Facility
NAVAIR	Naval Air Systems Command
NDI	Non-Destructive Inspection
NDT	Non-Destructive Test
NESO	Navy Engineering Support Office
NIF	Naval Industrial Fund
NSN	National Stock Number
PAR	Progressive Aircraft Rework
OPDOCS	Operational Documents
PEMS	Plant Equipment Management
SDA	Source Data Automation
SDLM	Standard Depot Level Maintenance
SPI	Standard Procedure Instructions
SRC	Scheduled Removal Component
SSI	Structurally Significant Item
TAT	Turn-Around Time
TDC	Technical Directive Change
TMS	Type/Model/Series
WCS	Workload Control System
WIP	Work In Process
WIS	Weekly Induction Scheduling
WUC	Work Unit Code
VAST	Versatile Avionics System Test
3-M	Maintenance Material Management

I. INTRODUCTION

Corrosion is defined as:

> "the action, process, or effect of wearing away gradually . . . usually by chemical action." [Ref. 1]

Corrosion, in the United States, is very costly. In 1975, this cost was estimated at $70 billion. This was 4.8 percent of the estimated Gross National Product for that year. [Ref. 2:p. vii] In 1975, the economic impact of corrosion in the U.S. Navy was estimated at $151.6 million for aircraft alone. [Ref. 2:p. A-6] The cost of this deterioration to our equipment must be covered by already scarce fiscal resources, thereby limiting the total quantity and caliber of the equipment we are able to purchase and maintain in an operationally ready status.

In addition to the direct costs of corrosion prevention, detection, and repair, we must also recognize the incalculable cost of lives lost as a direct result of corrosion as well as the high cost of loss or damage to valuable aircraft. The following examples highlight just how serious corrosion can be to Naval Aviation.

In 1978, a Navy fighter aircraft executed a hard landing during night carrier qualifications. Upon touchdown, the aircraft split longitudinally, causing the internal fuel cells to rupture. The ensuing fire impelled the aircrew to eject and led to the death of one of them. The aircraft was

a total loss. Although the landing was harder than normal, the sink rate was not sufficient enough to have caused the catastrophic disintegration and fire. Metallurgical analysis of the wing revealed indications of tensile overload and intergranular corrosion. In this instance, corrosion in a normally inaccessible area of the aircraft was a prime cause leading to the loss of a valuable asset and an invaluable life. [Ref. 4:p. 2]

Also in 1978, an F-4J was in the process of executing a normal field landing. Upon touchdown, the right main wheel assembly departed from the aircraft. The pilot diagnosed the situation as a blown tire and selected military power in an attempt to waveoff the landing. Unfortunately, the right-hand strut stub caught the field arresting gear, causing the aircraft to depart the runway approximately 2000 feet from the approach end. Upon departure, the left-hand strut collapsed and fire was observed coming from the right side of the aircraft. Both aircrewmen successfully ejected, but the aircraft had to be stricken from the inventory. The cause was determined to be failure of the right-hand main landing gear inner barrel assembly due to stress corrosion cracking and fatigue. [Ref. 4:p. 4]

Research of the Naval Safety Center records reveals that there were 93 reportable aircraft mishaps with defects due to corrosion listed as the prime or contributing causal factor during the period January 1978 through August 1985.

[Ref. 4] This provides strong evidence that it is crucial for supervisors at all levels of Naval aviation maintenance to have the necessary information to actively manage corrosion discovery, prevention, control, and repair activities.

A. PROBLEM DEFINITION

Naval aviation maintenance is divided into three distinct levels: organizational; intermediate; and depot. In order to minimize corrosion related costs, it is necessry to maintain an accurate, up-to-date, and interactive system for documenting and analyzing areas of aircraft which exhibit corrosion at any of these three maintenance levels. The Navy currently collects organizational and intermediate maintenance level corrosion information under the Maintenance Material Management (3-M) system. This system provides continuous input of aircraft discrepancy information to the 3-M data base maintained by the Naval Aviation Maintenance Support Office (NAMSO), and to the Naval Aviation Logistics Data Analysis (NALDA) system data base. [Ref. 5] The NAMSO data base provides hard-copy and microfiche historical trend analysis reports while the NALDA data base is used as a real-time, on-line computer accessed information system linked with selected Naval activities. These two systems were designed to provide Naval managers

with reliable information, in the desired format, for use in making management decisions. The concept of this management information system is sound, but it has one distinct flaw; information from the depot level of maintenance is missing.

This lack of information was readily apparent when we began researching our original topic. Our initial efforts were directed at discovering those areas of the S-3 which exhibited significant amounts of corrosion during SDLM and then comparing those areas with both the SDLM specification and the organizational level corrosion related maintenance requirements. The intended purpose of this comparative analysis was to:

1. Determine if there were significant areas of corrosion that were not included in the SDLM specification or the organizational level maintenance requirements. With such areas identified, determine which level of maintenance could most effectively perform the required inspection/correction actions.

2. Determine if significant amounts of corrosion were being discovered during SDLM in areas that were covered by the organizational level maintenance requirements. This information would have been presented to various S-3 squadrons in an attempt to identify reasons why the corrosion was not being discovered and treated. The intended result was to highlight such reasons as a lack of organizational training, ambiguously written maintenance requirements, lack of proper equipment, etc., in an effort to determine solutions to them.

Our initial efforts to locate the depot level corrosion documentation necessary to conduct the analysis led us rapidly to one conclusion. The only way of identifying corrosion discrepancies discovered on S-3's at NARF Alameda

was to manually audit every shop order document and SSI form that had been generated against every S-3 which had undergone SDLM. We attempted this with a sample of ten aircraft and soon realized that the task was monumental. Besides encountering the difficulties associated with retrieving large amounts of archival data, we soon discovered that much of the documentation was illegible, lacked much of the pertinent information (e.g., part numbers, types of corrosion, extent of corrosion information, expended man-hours, etc.), and followed no standard reporting format. Realizing that needed information was not available to NARF managers prompted us to investigate the possibility of correcting this problem. This report is intended to document the results of our research and convey our conclusions and recommended course of action.

B. RESEARCH METHODOLOGY

This report describes the problem as it pertains to the depot level Naval Air Rework Facility (NARF) Alameda, CA. As a vehicle, we have chosen the S-3 aircraft.

Our research approach was to conduct personal interviews and review applicable instructions and other written guidance. The first major task was to familiarize ourselves with the NARF Alameda corrosion documentation system. Our initial step was to determine how the NARF is currently

required to document corrosion discrepancies. Step two involved tracking actual corrosion discrepancies through the NARF to determine how they are being documented in practice. Step three is a comparative analysis of these two systems to highlight any inconsistencies.

Our second major area of research investigated documentation uses with the following objectives:

1. Identify any uses that are being made of documentation from the current in-practice system.
2. Determine documentation usage requirements identified in written guidance.
3. Identify additional desired uses of corrosion documentation.

The final step in this section was to determine which of the uses can be accommodated by the current NARF documentation system and which would require a new/revised system to provide the necessary capability/information to meet the requirement.

Section three provides a revised/new system (if one is required) that will meet the optimum number of user requirements within stated constraints. Finally, a general implementation plan for the revised/new system which will minimize the impact to NARF Alameda operations is presented.

II. CURRENT REQUIREMENTS AND PROCEDURES

A. REVIEW OF DIRECTIVES

A review of applicable instructions and guidance revealed only two documents that contained information concerning depot level corrosion documentation requirements. The first document, the Standard Depot Level Maintenance (SDLM) Specification of Dec. 1983, describes the SDLM tasks that are necessary to achieve the design reliability and operational availability of the aircraft during its next operating service period. [Rev. 6:p. 1-2] These tasks include, but are not limited to, aircraft zonal inspections for corrosion as well as the examination of specific parts or aircraft locations for possible corrosion.

The documentation requirements for these evolutions are specified in the SDLM specification as follows:

> "Inspection for and reporting of corrosion is required for zonal and structural line items . . . and shall be reported by identifying the area and using the corrosion codes . . .. Corrosion found during an SSI shall be reported on the SSI data form. Corrosion found during a zonal inspection shall be reported on the zonal inspection form." [Ref. 6:p. B-2]

An interview with the cognizant engineer revealed that no such "zonal inspection" form exists. [Ref. 7]

The acronym, SSI, mentioned in the previous quote, stands for Structurally Signifcant Item. SSI's are defined

in the second of the two documents which provide corrosion documentation guidance as:

> "Those local areas of primary structure which are identified by analysis to be the most important due to vulnerability to fatigue and/or corrosion and failure effect."

SSI inspections are the heart of the structural sampling program and are used as the basis for assessing the overall material condition of the aircraft. [Ref. 8:p. 1]

To ensure that the necessary corrosion related information is received from the structural sampling program, numerous components of the NARF organization must fulfill specifically assigned responsibilities. In general, the Engineering Division has overall control and responsibility of the SSI program. They define those items to be included in the SSI program and determine what data must be gathered. The other major involved groups include E&E, NDT, and various production branches which have requisite equipment and/or skills necessary to complete the required inspections. Appendix A identifies the specific components and their respective responsibilities. [Ref. 8: pp. 2, 3]

The two documents [Ref. 6 and Ref. 8] appear to be well integrated with the exception of defining who is responsible for completing and routing all required SSI forms to the cognizant engineer. The Standard Procedure Instruction

directs that the E&E branch, the production department, and the non-destructive test section each carry these responsibilities for the SSI's under their purview. [Ref. 8: pp. 2, 3] The SDLM specification states that:

> "The Examination and Evaluation Branch (E&E) shall prepare Structural Sampling Program reports . . . and submit a complete package of reports to NESO Code (311) at the completion of SDLM for each aircraft." [Ref. 6:p. 2-16]

There is an error in the previous quote. The Navy Engineering Support Office (NESO) Code (311) should read NESO Code (312). No other specific means of documenting corrosion discrepancies was located.

B. IN-PRACTICE DOCUMENTATION PROCEDURES

As revealed in the previous section, the available guidance on corrosion documentation is minimal at best. This section is intended to provide a thorough description of the current in-practice documentation procedures as they relate to the normal SDLM production flow.

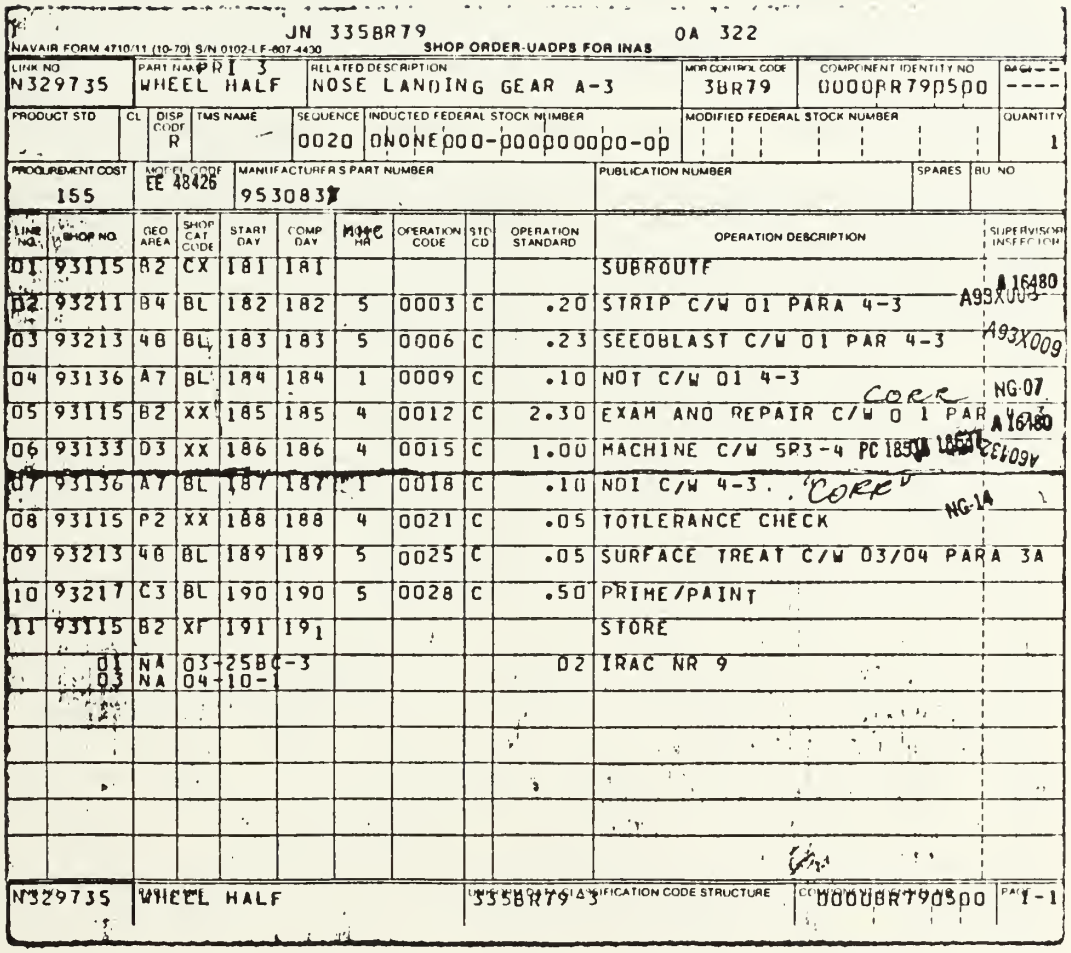
Since the SDLM process may not be familiar to all readers, we have segmented it into nineteen steps. They cover the major areas from aircraft receipt at the NARF through testing, disassembly, rework, reassembly, and delivery. A complete listing of the steps can be found in Appendix B.

1. Shop Orders

Throughout the above process, three basic forms are used to document corrosion discrepancies. The first form is the shop order. This is a standard form (NAVAIR Form 4710/ 11) used at all NARF's and is the primary source of printed information about the rework process.

Approximately ten days before the scheduled receipt of an aircraft, the E&E supervisor contacts the Program Planning and Control Division to request that the preprinted shop order documents (Figure 1) be prepared for that airplane. At this time the planner accesses the computer and inputs accounting and identification information for the particular aircraft into the Master Data Record (MDR) format. The MDR is a computer file that contains the specific task descriptions for all normally scheduled SDLM operations and many unscheduled operations which the NARF engineering staff feels warrant inclusion. The basis for inclusion is normally a high frequency of occurrence or extreme severity of discrepancy consequences.

Once the unique aircraft information is uploaded into the MDR format, the first batch of shop orders is computer generated at the local Navy Regional Data Analysis Center (NARDAC) and delivered to E&E. The current practice is to provide cards for all of the SDLM work packages, but



JN 3358R79 0A 322

NAVAIR FORM 4710/11 (10-70) S/N 0102-LF-807-4400 SHOP ORDER-UADPS FOR INAS

LINK NO	PART NAME	RELATED DESCRIPTION	MOR CONTROL CODE	COMPONENT IDENTITY NO	BASIC
N329735	PRI 3 WHEEL HALF	NOSE LANDING GEAR A-3	3BR79	0000BR790S00	----

PRODUCT STD	CL	DISP CODE	TMS NAME	SEQUENCE	INDUCTED FEDERAL STOCK NUMBER	MODIFIED FEDERAL STOCK NUMBER	QUANTITY
		R		0020	0NONE000-0000000000-00		1

PROCUREMENT COST	MODEL CODE	MANUFACTURER'S PART NUMBER	PUBLICATION NUMBER	SPARES	BU NO
155	EE 48426	953083			

LINE NO.	SHOP NO.	GEO AREA	SHOP CAT CODE	START DAY	COMP DAY	MAN HR	OPERATION CODE	STD CD	OPERATION STANDARD	OPERATION DESCRIPTION	SUPERVISOR INSPECTION
01	93115	B2	CX	181	181					SUBROUTE	A 16480
02	93211	B4	BL	182	182	5	0003	C	.20	STRIP C/W 01 PARA 4-3	A93X003
03	93213	48	BL	183	183	5	0006	C	.23	SEEOBLAST C/W 01 PAR 4-3	A93X009
04	93136	A7	BL	184	184	1	0009	C	.10	NOT C/W 01 4-3 CORE	NG-07
05	93115	B2	XX	185	185	4	0012	C	2.30	EXAM AND REPAIR C/W 0 1 PAR	A 16480
06	93133	D3	XX	186	186	4	0015	C	1.00	MACHINE C/W SP3-4 PC 185	A60132
07	93136	A7	BL	187	187	1	0018	C	.10	NOI C/W 4-3. "CORE"	NG-14
08	93115	P2	XX	188	188	4	0021	C	.05	TOTLERANCE CHECK	
09	93213	48	BL	189	189	5	0025	C	.05	SURFACE TREAT C/W 03/04 PARA 3A	
10	93217	C3	BL	190	190	5	0028	C	.50	PRIME/PAINT	
11	93115	B2	XF	191	191					STORE	
	01	NA	03-25BC-3						02	IRAC NR 9	
	03	NA	04-10-1								

N329735	WHEEL HALF	3358R793	0000BR790S00	PAGE 1-1

Figure 1. Shop Order Document

procedures have been instituted to allow for tailoring of this output so only the cards for those work packages that are required on the particular aircraft are printed. Applicable work package determination is made by consulting the work package selection matrix [Ref. 6:pp. 2-38 - 2-42].

The shop orders described above list the steps that are necessary to complete all of the scheduled requirements listed in the SDLM specification. A second set of shop orders is printed following the completion of step 4 in the SDLM process. These documents are virtually identical to those in the initial batch except that they are used to control the production effort for airframe and component discrepancies which were identified during the initial aircraft evaluation (the first "shake").

Following this second printing of shop orders, a document request card deck (the "bluestripe" deck) is also printed. This deck of IBM cards identifies those items listed on the MDR for which shop orders have not been printed and serves as a means of generating additional shop orders for components which are found to be faulty during the remainder of the SDLM process. It is used primarily by the material control center member assigned to the task of attaching the proper documentation to components removed at the disassembly point.

A third type of shop order that is used to document discrepancies is called an "unpredictable." This is also a computer generated NAVAIR Form 4710/11, but instead of listing a specific component or inspection and its related subtasks, it only contains the necessary accounting and generic aircraft identification information and a standard "comply with the following" task statement. This shop order is used to document discrepancies for which there is neither a specific preprinted shop order nor a card in the "bluestripe" deck.

2. "Handwrites"

The second type of form used for documenting corrosion discrepancies against the airframe and removed components is the local shop order (Figure 2). It is called a "handwrite" at NARF Alameda and is initiated when neither a preprinted shop order for that specific component/task nor an "unpredictable" is available. As previously mentioned, the "unpredictable" form has the aircraft and accounting data already preprinted on the form and keypunched into the accompanying job card. This is not so with the "handwrite." It only has the link number preprinted and prepunched. All other aircraft and accounting information must be written on the document and manually keypunched into the transactor system. This additional amount of required processing time makes the "handwrite" a less desirable means of documenting

discrepancies than via the preprinted shop orders. Use of the "handwrite" also causes another problem which is common to the use of an "unpredictable." The computer tracking system (MIS/INAS) in use at the NARF is not programmed to accept discrepancy descriptions about items that are controlled via these types of shop orders. This limitation deprives both managers and engineers of information that is necessary for making good decisions regarding such things as production flow, manpower/skill allocation, aircraft condition, etc.

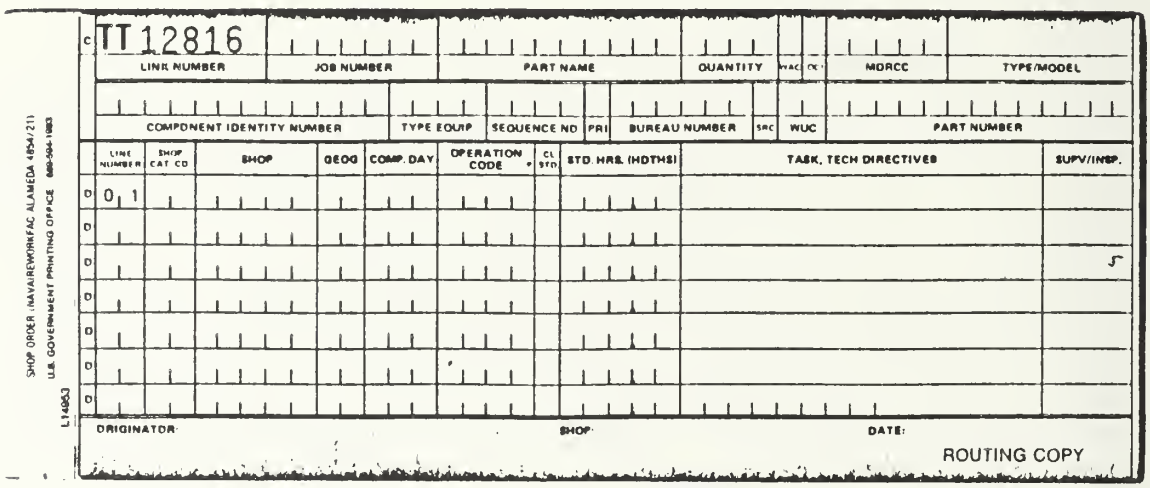


Figure 2. Local Shop Order

3. Structurally Significant Items

The final form used to document corrosion is the SSI record. The SSI program was presented in the previous section, but the "in-practice" operation of this program leaves much to be desired. The current procedure for

handling the SSI program begins with the E&E branch. They currently stock photostatic copies of the SSI's (front sides only) and have them grouped by the work packages of which they are a part. Upon aircraft induction, E&E pulls the necessary SSI packages from their files and determines which ones are within their capability to complete. Those that are outside of their capability are forwarded to the particular shop which E&E feels has the required skills/ equipment. This forwarding of the SSI documents is generally accomplished at the time the E&E examiner conducts his evaluation of removed components (at the "RZ" table in the disassembly area). The SSI record is placed with the shop order which is attached to the removed component. When the component reaches the responsible shop, the SSI inspection should be conducted and the SSI record properly completed and forwarded to NESO Code (312).

C. ANALYSIS OF REQUIRED AND ACTUAL PROCEDURES

1. Preprinted Shop Orders

In its present state, the MDR, which is used to generate all preprinted shop orders, does not contain specific line items for the documentation of corrosion. This causes the E&E and production personnel to make handwritten notations on the shop orders for those components on which they have discovered corrosion. This

method of documentation appears to work well for correcting the discrepancies, but is virtually useless as a method of gathering meaningful data on the incidence of corrosion on an individual component or the entire aircraft. Additionally, this lack of separate line items for corrosion causes the man-hours expended in its detection and correction to be combined with the man-hours expended on the correction of the primary maintenance discrepancy. Therefore, it is impossible to "breakout" these corrosion related man-hour expenditures either by computer or manually.

2. "Handwrites"

The problems associated with collecting corrosion data for items being reworked under a "handwrite" are very similar to those previously addressed for items being processed under preprinted shop orders. There is generally no specific line item assigned for the recording of corrosion information, and the current computer system does not allow for the entry of descriptive data from either "handwrites" or "unpredictables."

3. Structurally Significant Items

Although the instruction governing the SSI's [Ref. 8] is well written and provides most of the necessary procedures needed to successfully operate the program, there are some areas that need revision. The first of these

concerns the inconsistency with the current SDLM specification [Ref. 6] regarding routing of completed SSI's. The second area concerns the procedures to be followed in the Engineering Branch when completed SSI's are received (e.g., checking to ensure receipt of all required forms, data review requirements, document filing and retention requirements, etc.). The final major area concerns procedures that need to be followed when a required SSI inspection has not been completed. Additionally, when the instruction is revised (last revision was 1977), particular emphasis should be placed on ensuring that all delineated procedures are viable on the production floor.

A thorough review of the SSI program, as it is currently being practiced [Ref. 9], revealed numerous discrepancies. Appendix C delineates these. In general, the cause of the discrepancies appears to be threefold: weaknesses in the governing instruction [Ref. 8]; ignorance about or disregard for the current instruction; and inadequate management attention. Immediate steps must be taken to correct these problems if the structural sampling program is to fulfill its originally intended purposes.

III. CURRENT DOCUMENTATION USES

A. DATA ENTRY

NARF Alameda is currently using the Management Information System for Industrial Naval and Marine Corps Air Stations (MIS/INAS). It is comprised of the Workload Control, Material Control, and Financial Control application groups. Although the latter two systems are not currently operational at any of the NARF's, a brief overview is given for continuity purposes. The remainder of this chapter focuses on the Workload Control System.

Both the Material and Financial Control Systems are currently in the development phase. The Material Control System will utilize on-line data base techniques to provide a standard material accounting and reporting system for all of the NARF's. It will consist of ten major applications which are listed in Appendix D [Ref. 11]. The Financial Control System will provide a fully mechanized financial accounting and reporting system that will carry out cost and general accounting functions and provide management with related information. Appendix E [Ref. 11] provides a general description of the nine major applications of this system.

As the name implies, the Workload Control System was designed as an automated aid for NARF management to use in

scheduling, monitoring, and controlling the production efforts of the facility. One of the primary outputs of this system is the maintenance documentation form (i.e., pre-printed shop orders, job cards). The generation of these forms is a direct function of the interaction between the MDR and OPDOCS applications. Data entry for all applications is accomplished either via the transaction recorder or a standard computer terminal. The feedback application serves as the initial collection point for this data, and all other system applications are updated from this source. Other applications store and collate data, and provide various reports used in managing the work flow at the NARF. Appendix F [Ref. 11] provides additional information about the various Workload Control System applications.

Original system procedures required that each artisan use a transaction recorder to update the computer when beginning and completing a line item on a shop order. These maintenance data entries were to be made in "real time" throughout the work day so management could obtain an accurate picture of all production efforts at any time. Our observations of current practices indicate that these original procedures are being disregarded in most cases. The majority of shops do not make "real time" data entries, but do a batch processing of the completed shop orders/line items at the end of each shift. Normally, the shop

supervisor or a specially designated alternate inputs the data.

Two primary reasons for this deviation from designed procedures were found. First, it appears that some supervisors want to retain close control over what data is entered into the system. Possible reasons for this span the spectrum from ensuring the accuracy of entered data to screening the data to ensure that the shop is awarded a high efficiency rating.

The second major reason cited for batch processing the data entries deals with training and personnel turnover. The high turnover rate at NARF Alameda (estimated by some shop supervisors to be as high as 50% per quarter for certain positions) would require that a significant amount of the supervisor's time be spent in training his new personnel on how to make the required data entries. Most supervisors felt that it was easier and a better utilization of their time to restrict the data entry task to themselves and one or two personnel with long term retention desires.

B. CURRENT USES OF CORROSION DOCUMENTATION

As mentioned previously, the SDLM specification [Ref. 6] mandates the collection of corrosion discrepancy documentation. Accurate collection of all such data is necessary so that the condition of aircraft systems and

structures can be monitored for deterioration due to corrosion and corrective/preventative actions taken as required. At present, corrosion is being discovered and documented, but only in a manner suitable for use by those directly involved in the repair process. This documentation, as mentioned in Chapter I, is totally unsuitable for modern analysis techniques.

Our investigation indicates that the primary cause of this problem is related to the design of the Workload Control System. Specifically, the current Master Data Records (MDR) do not contain line items designated for the documentation of corrosion discrepancies [Ref. 11]. This deficiency has a twofold impact. First, the preprinted shop orders are generated without such line items, and secondly, the feedback system, which interacts with the MDR and OPDOCS applications to determine allowable data inputs, will not accept any information unless its requirement is delineated in these applications. Since there are almost no line items for corrosion documentation, the majority of all time spent on these actions is simply included in the total time documented against line items for other tasks. Additionally, since the feedback application will only accept data entries for line items that exist in the MDR, descriptive information about corrosion discrepancies cannot be entered into the system. Only data about line items that are devoted to the correction of specific corrosion

discrepancies (and these are very rare) is entered into the data base. For these reasons, the majority of corrosion information is never entered into the Feedback system and, hence, is unavailable to the engineers and managers who need the data for making their analyses and decisions.

C. ADDITIONAL DESIRED USES OF CORROSION DOCUMENTATION

As previously indicated, the incidence of corrosion is only being documented for purposes of discrepancy correction, and information about these discrepancies is not readily available to NARF management. Based on the assumption that all corrosion related information (i.e., type, extent, location, man-hours expended, skills used, material used, etc.) could be collected, we interviewed numerous managers and engineers to ascertain their desired uses and such information. The following list is a compilation of these uses.

1. COST CONTROL.

   With the current paucity of fiscal resources and the likelihood of future budget reductions, it is imperative that all governmental activities closely monitor all tasks that consume these resources. The expenditures for time and materiel used in the detection, correction, and prevention of corrosion at NARF Alameda are presently hidden from those managers who must exercise this control. Some means of breaking out these obscured costs is needed.

2. BUDGET JUSTIFICATION.

   Another implication of fiscal "belt tightening" is the increased need for very specific justification when submitting budget requests. It is currently

impossible to justify funds for corrosion work, since no current or historical records detailing resources used for this purpose exist. This same sort of information is required in the near term when unforeseen circumstances make it necessary to request budget augmentation during the fiscal year.

3. CEILING POINT INCREASES.

When requesting a manning level increase, it is necessary to show that the requirement exists for the additional man-hours and requisite skills. Accurate documentation of the number of man-hours, by skill category, that are expended on corrosion maintenance actions is necessary to provide this historical data base.

4. STANDARD TIME CALCULATIONS.

The scheduling of aircraft and components to be reworked at the NARF is dependent not only on the available man-hours, but also on the amount of work needed to return the item to the desired level of operability. Since the amount of time currently being spent on corrosion maintenance is unknown, it must be estimated when calculating standard repair/rework times. On the surface, it has far-reaching consequences. The standard times allocated for the rework/repair of aircraft and components is one of the primary factors limiting the number of assets that can undergo depot level maintenance during a given period. With this limitation, additional aircraft and repairables must be procured to alleviate the fleet shortage which inevitably occurs.

5. OPERATING SERVICE PERIOD ADJUSTMENTS.

Since the current documentation procedures provide minimal corrosion information to the engineering staff, it is possible that the rate of aircraft deterioration due to corrosion may be exceeding the original design estimates. Unless specific information regarding the extent, types and locations of corrosion is available for analysis, it is impossible for engineering to make this determination and appropriately modify the length of time allowed between SDLM's.

6. MODIFICATION OF MAINTENANCE REQUIREMENTS/PROCEDURES.

Information about extent, types, and locations is important for another reason. Analysis of this type of information is essential in determining whether the published maintenance requirements are sufficiently clear and complete to ensure that corrosion is either prevented or detected and corrected in its earliest stages. If, for example, a trend of corrosion in a particular area was identified, the NARF engineering staff could search for the cause. These might include such things as poorly written maintenance requirements, inattentive maintenance personnel, insufficient training, improper uses of equipment, etc. Once the cause(s) is identified, the appropriate corrective action can be initiated.

The ability to provide managers and engineers with the above types of information requires two things: more complete data and an improved system for its processing. It is evident that either the current Workload Control System must undergo major modifications or a new system for collecting the necessary data and generating desired reports must be instituted.

IV. DATA COLLECTION ALTERNATIVES

When first organizing this report, our initial intent was to investigate possible alternative means of gathering and processing the needed corrosion data. We briefly reviewed the Workload Control System and determined that significant changes would be required for this system to respond to the needs of managers and engineers in a suitable fashion. We also discovered that NARF Cherry Point was working on a prototype system [Ref. 11] that would provide the engineering staff with some of the desired data, but would not, in our opinion, provide the information in a format suitable for use in a Navy-wide maintenance data management system.

At this point, we discovered the Depot Maintenance Data System (DMDS) and found that a phased implementation schedule for all NARF's commenced on 1 Sep. 1980 [Ref. 5:p. 17.3]. Since usage of this system for data collection is required, we focused our attention on it to determine if it would provide the corrosion related information desired by the NARF. The remainder of this chapter will describe the DMDS system, its benefits, weak areas, and a general implementation plan for NARF Alameda.

A. DMDS DESCRIPTION

The current DMDS program manager is located at the Naval Air Systems Command (AIR-41111). He has the overall responsibility for system design and operation. The project leader is located at the Naval Aviation Logistics Center (NALC-613). He acts as the program manager's assistant and coordinates between the various NARF's involved in the DMDS project. NARF Cherry Point and NARF Jacksonville are directly involved in the development of DMDS because of their role in the MIS/INAS, of which DMDS is a part. NARF Cherry Point, as the feedback application manager, writes the program specifications for all approved program change requests. They also test them for proper operation prior to their release to the other NARF's. NARF Jacksonville writes the software programs for all DMDS program change requests.

> "Maintenance data is reported at the organizational and intermediate levels under the 3-M system; DMDS closes the maintenance reporting loop by providing continuous maintenance information on aircraft, engines and components repaired at the depot level. The DMDS provides the mechanism to collect this information as the unified singular depot maintenance data system. This depot reporting system has been introduced into six Naval Air Rework Facilities (NARF's). DMDS must interface with many other systems and programs to accomplish the requirements established in the ILS program. In this role, DMDS interfaces with the Management Information System for Industrial Naval and Marine Corps Air Stations (MIS/INAS) as the depot maintenance system. DMDS fulfills the depot maintenance data collection requirements levied by ILS management programs and systems. DMDS feeds NARF maintenance data into the Naval Aviation Maintenance Support Office (NAMSO) 3-M data base and the Naval Aviation Logistics Data Analysis (NALDA) system data base,

so that continuous maintenance data will be available from each of these sources." [Ref. 5:p. 17.2]

Although the above quote states that the DMDS has been introduced into the six NARF's, it does not indicate that the system was essentially dormant, until recently, at NARF Alameda. It is hoped that this report will assist NARF Alameda in the complete and rapid implementation of this system.

The necessary DMDS hardware and software are both in place at NARF Alameda and will use the existing transaction recorders and computer terminals for data entry. According to the DMDS project leader (Mr. Ed Laigle, NALC 613D), the MDR's at all NARF's were reviewed and updated to include the needed DMDS coding. The purpose of this coding is to allow the WCS to print the shop orders with a "DMDS REQUIRED" statement. This coding will also enable the printing of the necessary DMDS cards that can be used for entering data into the system. To date, none of the MDR's at NARF Alameda allow for the printing of this DMDS peculiar documentation. A review of the MDR's is currently in process to correct this deficiency.

The DMDS currently consists of 55 separate data elements. Several of these elements provide aircraft/component identification information (i.e., bureau number, component identity number, part number, part name, serial number, type/model/series name, and work unit code)

while others describe the discrepancy and the corrective action (i.e., action taken code, corrosion type code, extent of corrosion code, malfunction code, etc.). Appendix G provides a complete descriptive list of these DMDS data elements. [Ref. 13]

DMDS information will be gathered from a broad spectrum of depot mechanics, examiners, production controllers and supervisory personnel across the aircraft, engine and F/E programs. The DMDS accepts input data from either manually documented cards and forms or automated data entry sets. All information is coded and filed within appropriate MIS/INAS files until retrieval is required. There are several alternate paths available for data entry and each NARF may select the operating mode best suited to its operation. The possible choices include the use of preprinted cards which would be annotated, blank forms that require more handwritten entries, automated data entry, or a blend of all three. Our research indicates that NARF Norfolk currently uses the preprinted cards with a centralized keypunch operation. NARF Cherry Point prefers to use the transaction recorder method of data entry. Both facilities also make use of forms and computer terminals when appropriate.

B. GENERAL IMPLEMENTATION PLAN

In designing an implementation plan, we feel that the following items should be primary considerations: funding, manpower requirements, training requirements, resistance to change ("selling" the system), and time constraints. In the past, special funds have been earmarked for hardware installation and the uploading of the necessary software at NARF Alameda. A special fund was also used to pay for the review and modification of the MDR files to make them DMDS compatible. Additionally, funds were recently made available to allow for the hiring of a GS-12 as the DMDS coordinator. This position is currently held by Mr. Richard Cohen (Code 521). Although we see no need for any additional major funding at this time, it is possible that some money will be required to fund the initial training of all involved personnel, and possibly the hiring of additional data process/keypunch personnel.

In reviewing the need for additional manpower, we must discuss the two possibilities for entering data. The first, currently in use at NARF Norfolk, involves the shop personnel manually completing the appropriate DMDS card or form and forwarding it to a central keypunch office. Here, the handwritten documents are keypunched and batch entered into the computer. If this data entry method were utilized at NARF Alameda, it is possible that additional keypunch

operators would be required. The second data entry method, currently in use at NARF Cherry Point, relies on individual shop personnel to directly input the DMDS data into the computer via the existing transaction recorders. With this method, no additional data entry personnel are required, but the current practice of having the supervisor and one or two other shop personnel make all transactions will have to be abandoned. Although this may require the expenditure of more time for training, it should improve the accuracy of the collected data since it will be more difficult for the supervisor to "balance" the expended man-hours to equal the standard times.

Two facets of training must be given consideration: initial and ongoing. We feel that the most effective means for conducting the initial training for shop personnel would be on a shop-by-shop basis. This would allow each shop to receive close instruction about DMDS until they achieved the desired level of competency. The second consideration would apply to training new hires and disseminating information about changes to the system. This ongoing training could be incorporated into the existing NARF Alameda training plan.

As with the incorporation of any new system, affected personnel will exhibit a resistance to the change. This must be overcome to allow the new system to be successful.

One of the best methods of doing so, is to show the affected personnel what rewards they will reap as a result of the system implementation. Identification of these rewards should be the starting point for all training sessions. Examples of these potential rewards include: increases in funded repair hours, producing a safer product, reducing costs, reducing the amount of unscheduled maintenance required, etc.

The need for closing the Naval aviation maintenance data loop was initially stated by the Chief of Naval Operations (CNO) in 1979 [Ref. 5:p. 17.3]. Since that time, the DMDS was conceived and its implementation directed. It is incumbent on all NARF's to rapidly make this system operational so their information will become available to those logisticians, engineers, and maintenance managers who need it.

C. DMDS BENEFITS

Implementation of the DMDS will generate numerous benefits [Ref. 14].

1. Improvement in the capability to justify, document, and validate maintenance requirements at all three levels of maintenance.
2. Improvement in the capability to assess the effect of time in service on depth of depot rework required.
3. Enable engineering to identify systems and components that exhibit various types and degrees of corrosion damage.

4. Enhancement of reliability centered maintenance analysis by verifying actual failure modes at the NARF.

5. Provision of quantitative inputs to logistics planning for new weapon systems and equipment.

6. Evaluation of training, publications, and support equipment by determining the percentages of components that arrive at the depot with no defects.

7. Permit analysis of pipeline time between operating levels and the depot and facilitate component tracking.

8. Decrease in the overall costs of production.

D. SHORTCOMINGS AND PROBLEMS

Although the DMDS will be very useful in its present form, we have identified several things which we view as either a system deficiency or an implementation problem. These include:

1. The system currently will retain only the latest entered malfunction code. If a component exhibits more than one malfunction, the artisan makes the determination about which one to report. This causes all man-hours expended on the repair of an item to be documented against that single malfunction and deprives the information users of failure occurrence data. One instance where this frequently occurs, involves the correction of corrosion discrepancies. DMDS allows for the collection of corrosion type and extent information, but unless the primary discrepancy is the corrosion, no corrosion related man-hours may be broken out.

2. DMDS will provide discrepancy location information by part number, component identity number, and work unit code. This information is helpful, but more detailed locational information is needed when documenting corrosion. For example, corrosion that is currently discovered on the airframe can generally be isolated to a particular subcomponent of the structure by use

of the work unit code, but DMDS will not currently allow for the recording of information about the location of corrosion on the subcomponent itself.

3. By designing a maintenance data collection system (DMDS) that was "piggybacked" onto a financial accounting/workload planning system (MIS/INAS), system incompatibilities have been circumvented by requiring that the same data be entered separately into each system. This has led to the waste of manpower and the proliferation of paperwork.

4. The system design, whereby all DMDS data is batch transmitted on magnetic tape vis the U.S. mail to NALDA and NAMSO, is antiquated and leads to an unnecessary time delay between data collection and data availability. The fact that NARF's can only gain access to their DMDS data either by requesting 3-M reports from NAMSO or by accessing the NALDA data base via computer terminal also creates time lags. Retrieving information from the NALDA data base is more expeditious, but the limited number of NALDA terminals at NARF Alameda, combined with frequent difficulties encountered in linking to the data base, also make this means of data retrieval less than "user friendly."

5. Successful implementation of DMDS has been hampered by a lack of standard training documentation and implementation guidance. Each NARF has essentially been left to its own devices to get DMDS "on-line."

V. RECOMMENDATIONS AND COMMENTS

Our investigation has led us to one major conclusion; corrosion documentation at NARF Alameda appears suitable for purposes of discrepancy correction, but wholly unsuitable for analysis. This lack of suitability stems from two primary causes: (1) current problems with the proper execution of the SSI program, and (2) inability to collect sufficient types of corrosion related information.

A. THE SSI PROGRAM

Our review of the SSI program indicates that the following changes are warranted:

1. The inconsistency between the current SDLM specification [Ref. 6:p. 2-16] and the governing Standard Procedure Instruction [Ref. 8:pp. 2, 31], concerning who is responsible for ensuring the proper completion and routing of SSI's, must be rectified. We recommend that NESO Code (312) assume this responsibility.
2. NESO Code (312) should develop a system that will allow him to maintain positive control over all SSI's that are required on aircraft undergoing SDLM. This type of control is necessary to ensure the integrity of this historical data base as well as ensuring that every aircraft undergoes its requisite inspections.

3. A thorough review of the current SDLM specification [Ref. 6] should be undertaken to ensure that all necessary SSI's are properly delineated therein.
4. All SSI forms should be reviewed, and revised as required, so that all information (i.e., measurement tolerances) needed to complete the inspection is preprinted. This will allow Code (312) to ensure that the most up-to-date specifications are being used to conduct the examinations. Additionally, this will eliminate the current requirement for the examiner/ artisan to refer to technical manuals or "gouge" sheets for this information.
5. All shops should be purged of blank SSI forms and the SPI requirement forbidding the reproduction of SSI forms, except as specifically authorized by Code (312), should be re-emphasized. This measure is necessary since the majority of blank SSI forms, currently held in the shops, are incomplete. Specifically, these unauthorized reproductions do not include the corrosion type and extent codes on the backs of the forms as do the originals. We feel that this missing data has directly contributed to the poor quality of corrosion information previously collected.
6. The current procedure, where E&E assigns the SSI to the appropriate shop, functions satisfactorily, but

preprinting the code of the responsible shop(s) would eliminate this requirement. This should also reduce the number of duplicate SSI's that are currently being received by Code (312).

7. SPI 4730.15 should be revised to include procedures that will ensure no aircraft completes SDLM without having all required SSI's properly completed. Inability to properly complete an SSI must be discovered as rapidly as possible to prevent the waste of man-hours which could result from duplicate disassembly/reassembly actions necessary to access the SSI.
8. All completed SSI's should be retained until a permanent summarization, by bureau number, can be generated. This summarization should include all pertinent information and should be retained indefinitely, since this is the historical data base utilized in making various engineering decisions.
9. All personnel involved in the SSI program should receive refresher training on the revised program and strong management attention, to ensure compliance, should be brought to bear.

B. THE DEPOT MAINTENANCE DATA SYSTEM (DMDS)

The need for accurate, timely, computerized information is becoming more critical as each day passes. As our weapon systems become more complex and expensive, and public pressure

for effective management mounts, it is imperative that those tasked with the maintenance of these systems get the best information possible. The DMDS will provide much of this information and will produce many benefits as we have previously indicated in Chapter 4. Even though implementation of this program has been directed by higher authority, it is in NARF Alameda's best interest to get the system "on-line" as soon as possible so these benefits can be used in making NARF operations more efficient and effective. The following recommendations and comments are provided to assist in this effort.

1. The NARF Alameda DMDS coordinator should conduct a thorough on-site review of DMDS operations at the more successful DMDS implemented facilities (i.e., NARF Norfolk and NARF Cherry Point). Specific attention should be paid to gathering information on how to implement the program and the best means of conducting day-to-day DMDS operations. The collection of any written plans/guidance is crucial.
2. The DMDS coordinator should author two documents to be used at NARF Alameda. The first should be a comprehensive DMDS implementation plan. This plan should be as detailed as possible and should provide milestones to facilitate positive tracking of all phases of the implementation process. The second document

should be a NARF Alameda instruction that delineates program objectives, specific areas of responsibility, operational procedures, and all other information necessary for the smooth operation of the DMDS program at NARF Alameda. These two documents should be completed prior to beginning program implementation so that all efforts can be coordinated to achieve the desired goals. Additionally, the governing instruction should be used as a primary aid in training the personnel who will be involved in the DMDS program.

3. Initial training of personnel should be conducted on a shop-by-shop basis with priority given to training the shops in the order in which the various DMDS card types must be entered into the system (i.e., shops entering card type 41 should be fully functional prior to activating DMDS data entry from shops that normally complete card type 2-02/04). Initial training should be conducted under a special training plan, but training for new-hires and periodic refresher training can be incorporated into the existing NARF training plan.
4. Two of the more effective DMDS operations use different methods to accomplish data entry. NARF Norfolk requires their personnel to complete the required cards/forms and forward them to a central data processing office. This office then keypunches the data and enters all data via

batch processing. NARF Cherry Point utilizes similar cards and forms, but requires the originating personnel to enter the data into the computer via the transaction recorders. We recommend that NARF Alameda utilize the second method for data entry for the following reasons:

a. The accuracy of collected data should improve since the person who completes the maintenance action will also be entering the data.

b. There will be no requirement to hire new data processing personnel (with the possible exception of those shops such as E&E which will make a significant number of DMDS transactions).

c. Shop supervisor's time will no longer have to be spent doing data entry, but can be utilized in other more pressing areas.

d. Data entry will occur in a more timely manner.

This method of data entry should also be required for the current existing MIS/INAS requirements as well. Strong management attention and an organized training plan will be required to ensure the proper implementation of this recommendation.

5. Since preprinted DMDS cards are only available for those components listed in the MDR, it is essential that the MDR include as many aircraft components as possible. [Ref. 14] Not only will this minimize the requirement to initiate a "handwrite" shop order, but it will also minimize the requirement to use the more cumbersome DMDS forms vice the preprinted cards. This should result in

more accurate data collection, increased personnel efficiency, and a time savings.

6. The MDR should be revised so a separate line item for corrosion discrepancy correction is included in the record for each component. Completion of this step will provide the engineering staff with information about which components are exhibiting corrosion, and the number of man-hours being expended to correct the problems.

C. GENERAL COMMENTS

Although implementation of the DMDS will close the aviation maintenance data reporting loop and provide engineering with some excellent data for their analysis, we discovered two areas that need improvement before the system will provide the desired corrosion data. The first of these concerns the system's lack of ability to pinpoint the exact location of corrosion on large components and the airframe. Although the work unit code and part number provide a general location to the subsystem or component level, engineering personnel need more specific locational data for use in determining those areas that require closer monitoring or changes to the published maintenance procedural documents. One possible means of accomplishing this would be to use a grid system (similar to a map coordinate system) that would allow computer compatible locational information to be

gathered on certain specific components. A thorough review of the aircraft should be conducted to determine what areas are not sufficiently identified by the existing DMDS data elements and would require an alternate means to generate the necessary locational information.

Currently, DMDS will only retain one malfunction code (the last one entered) for each component. This results in all expended man-hours, whether expended in the correction of corrosion or the correction of the primary "downing" discrepancy, being reported against the malfunction code which best describes the primary discrepancy. The artisan currently makes the decision about which malfunction code to report. The only time that specific corrosion man-hour information is reported under the corrosion malfunction code is when the corrosion problem is the "downing" discrepancy. This makes it virtually impossible to extract accurate information from the NALDA/NAMSO data bases about the number of man-hours expended on the prevention/correction of corrosion discrepancies. To correct this situation, the system should be modified to either retain a supplementary malfunction code, or provide for specific reporting of man-hours expended for the correction/prevention of corrosion (similar to the current means of separately identifying the type and extent of corrosion).

Another area which we feel needs to be addressed concerns the two divergent purposes for which currently collected data is used. Although the MIS/INAS is designed to provide some maintenance discrepancy trend analysis, it is primarily used as an accounting tool. Since shop personnel realize this, the potential for data entry inaccuracies is present. We feel the majority of emphasis should be placed on collecting accurate information vice ensuring that the rework times never exceed the published time standards. The time standards are simply average times and infrequent or minor deviations from them should not be considered indicative of inefficient operations. With this shift in emphasis, we feel that the quality of collected data would improve, thereby allowing the engineering staff to better perform their duties.

We encountered two other areas of concern while conducting our research. These dealt with the requirement to send duplicate DMDS data tapes to NAMSO and NALDA and the current difficulties encountered with accessing the NALDA data base via the current terminal system in place at NARF Alameda. The DMDS program manager [Ref. 15] provided the following information concerning future events that will impact both of these concerns. First, current plans call for combining NALDA and NAMSO at Philadelphia, PA. This will negate the current requirement to transmit two data tapes. As to the second concern, Mr. Savage informed us that there were plans to

purchase System 63 IBM personal computers for the NARF's that would provide a better means of accessing the NALDA data base.

Our final comment applies to all facilities that have or will eventually be required to implement DMDS. It appears that this program has suffered from a high degree of personnel turnover at all levels. In an attempt to minimize resulting impact, we feel it would be advantageous to form a NAVAIR sponsored and funded assistance team that would be available, upon request, to activities that needed help in the implementation or operation of the DMDS.

APPENDIX A

SSI PROGRAM ORGANIZATIONAL COMPONENTS AND RESPONSIBILITIES

Weapons Systems Engineering Division (31000)

1. Analytically select the items on which material condition data is required.
2. Define all required material condition data elements.
3. Develop the SSI reporting forms.
4. Provide complete and concise instructions for the completion of SSI reporting forms.
5. Specify the interval at which the completed SSI reporting forms are to be returned to the cognizant engineer.

Office Services Division (11000)

1. Reproduce sufficient quantities of the SSI forms and dispatch them to specified locations as requested by the cognizant engineer.

Aircraft Analysis Branch (62100)

1. Generate Master Data Records (MDR's) from those maintenance requirements analytically developed by the cognizant engineer. These MDR's will be used to generate the shop orders which will specify the requirement for the SSI inspection during SDLM.

Aircraft Examination/Evaluation Branch (E&E) (52200)

1. Conduct SSI examinations as defined by the shop order documents and as their capability allows.
2. Direct removal and routing of all items requiring remote shop processing. Provide the appropriate control center (51000) with the necessary SSI reporting form(s).
3. Report the occurrence of any new or unusual anomaly to the engineering branch upon discovery.

Production Department (90000)

1. Process the SSI's in accordance with the shop order.
2. Report the occurrence of any new or unusual anomaly to the engineering branch upon discovery.

Production Control Division (51000)

1. Ensure the correct SSI reporting form accompanies each routed component.

Non-Destructive Test Section (42330)

1. Conduct the necessary tests/examination of the SSI as defined on the shop order document and the SSI report form.

APPENDIX B

S-3 SDLM PROCESS STEPS

1. Aircraft Receipt
2. Pre-induction testing
   a. Inventory and acceptance
   b. Functional systems checks
   c. De-arming pyrotechnic devices
   d. De-fueling
3. Decontamination
4. E&E verification of bulletin/change incorporation
5. Strip, vacublast, wash
6. Disassembly
7. E&E evaluates components and airframe
8. Airframe and component discrepancies corrected
9. Bulletins/changes incorporated; wiring checked
10. Components reinstalled
11. Seats rigged and checked
12. Systems checked; final set inspection
13. Final paint
14. Weight and balance checked
15. Functional ground test of systems
16. Functional test flight
17. Post flight paint touch-up
18. Outbound inventory conducted
19. Aircraft delivered to fleet

APPENDIX C

SSI PROGRAM DISCREPANCIES

1. There are insufficient procedures for filing completed SSI's to ensure continuity of this historical data base.
2. Numerous duplicate, completed SSI forms for the same sequence numbered aircraft were discovered.
3. No/inadequate justification could be located to account for several deletions/combinations/changes of SSI's between the original S-3 SDLM specifications [Ref. 8] and the current SDLM specification [Ref. 6].
4. Proliferation of incomplete/obsolete blank SSI forms in several shops has been accomplished by unauthorized reproduction of forms from various sources (generally from abbreviated example forms located in the SDLM specification).
5. All required SSI's are not being accomplished. The primary reason was component inaccessibility, but occasionally, inability of the artisan to locate the item was cited.

APPENDIX D

MATERIAL CONTROL SYSTEM APPLICATIONS

1. NARF Material Requirments.
2. Stock Replenishment Requisitions.
3. Physical Inventory Aids.
4. Material Turn-in Capability.
5. Change Notice Actions.
6. NIF Material Determination.
7. On-Line Inquiry/Reply.
8. Requisition Monitoring.
9. Management Reports.
10. Financial Interface.

APPENDIX E

FINANCIAL CONTROL SYSTEM APPLICATIONS

1. CUSTOMER ORDER--maintains current data related to all customer orders established within the NARF.

2. JOB ORDER AND SHOP RATES--maintains an integrated set of files that provides the authority to perform work and records work performed. Files contain valid shop numbers, current overhead statistics, acceleration rates, and uniform cost accounting data.

3. LABOR--raw labor transactions input, via the MIS for INAS workload control system feedback application, and the manual input additions, corrections, and adjustments to labor transactions are processed in this subsystem. Outputs include labor cost summaries and general ledger journal voucher postings.

4. MATERIAL--transaction inputs from the Material Control System are processed in this subsystem. Outputs include material cost summary reports and general ledger journal voucher postings.

5. OTHER COST--cash receipt and disbursements are controlled and processed in this subsystem. Detail vouchers are corrected, summarized and balanced to summary reports. Accruals are established and prepaid assets are liquidated.

6. COST AND EXPENSE--combines all costs processed through the labor, material, and other cost subsystems.

7. BILLING--provides for mechanized billing to customers.

8. GENERAL LEDGER--updates the general ledger with journal voucher records, and produces weekly and monthly trial balances for each general ledger account and year end general ledger closing entries.

9. UNIFORM COST ACCOUNTING--accumulates and reports costs of depot level maintenance for weapon systems supported or items maintained.

APPENDIX F

WORKLOAD CONTROL SYSTEM APPLICATIONS

1. MASTER DATA RECORD (MDR)--is designed to create and maintain, in an integrated set of files, all of the work processes required to process workload through a particular Naval Air Rework Facility.

2. OPERATING DOCUMENTS (OPDOCS)--provides for the preparation of all necessary documentation to identify work requirements, and process an item through the necessary production shops for repair, overhaul, test, etc. A Work-In Process (WIP) record is generated each time operating documents are prepared for a routable identity or a group of operations with a seven-character alpha/numeric link number. In addition to the Master Data Record File described above, other input data, such as: Master Application Code File, Master Schedule File, Workload Data, Schedule Changes, Manual Overrides, Special Induction Records, Document Request Card, Equipment Schedule Card, etc., are used to produce the operating documents. This provides a means of "tailoring" the operating documents to a specific aircraft bureau number or engine type and model.

3. FEEDBACK--pertains to the transaction recording and processing of data via the Source Data Automation (SDA) collection system. The data collected in this subsystem is

received from either the transaction recorder or from manual inputs in the form of handwritten shop orders, labor corrections, simulated messages when transacters are inoperative, planner changes, etc. This data applies to attendance, labor distribution, quality control and other production related data elements. The results of the processing are updated files and a series of management reports.

4. WEEKLY INDUCTION SCHEDULING (WIS)--pertains to the weekly induction scheduling of component program items. This mechanized scheduling routine accepts the Inventory Control Point requirements and computes an optimum induction schedule taking into consideration priority, capability, availability of carcasses, bits and pieces, trade skill hours and facility hours.

5. PRODUCTION STATUS--provides feedback data applicable to the repairable components program. Its master files maintain data at the National Stock Number (NSN) level related to items scheduled for induction source. It provides item completion date to the material usage application. By interface with the financial application, the Production Status application provides job number closing data and receives labor and material cost data generated by the items in the rework process. Output reports summarize this production and cost data for management use.

6. MATERIAL USAGE--provides for the collection and processing of requisition data for support material used in the rework of aircraft, missiles, engines, components and other work programs. As an integral part of the NARF Material Control Program, material usage data is produced from information supplied from Naval Air Rework Facility, Naval Air Station Supply Department, and Naval Air Station Comptroller Department records.

For aircraft, missiles, engines, and components, the material used and the production count are processed to compute a usage rate for each item of support material used on the end item. For general usage categories; i.e., manufacturing, fleet calibration, etc., the average material usage is computed.

The files and reports produced by the material usage program provide a historical record of material use, information needed for control of the program, and a basis for computing support material requirements for a projected rework schedule.

7. HISTORY--accumulates production completions to:

   a. Maintain a history of production activity for each routed work item at the operation level.

   b. Update the occurrence factors in the Master Data Records.

   c. Provide management with statistical history of planning purposes.

d. Provide statistical data for use in the preparation and justification of performance standards.

8. UTILITY--provides for various utility procedures which permit changes to and extractions from certain Master Files including organizational changes to the Master Data Record, Work-In-Process File, History File, Performance File, etc.

9. PLANT EQUIPMENT MANAGEMENT (PEMS)--is designed to provide current data concerning the status of equipment in the NARF. The Equipment Data Record (EDR) Master File is designed to include records for: Plant Account Equipment; Special, Standard, and General Support Equipment; Minor Plant and other miscellaneous types of equipment. Inventory listings and selected data reports are extracted from the EDR Master Files for the inventory and management of various equipment categories. A segment planned for the future in the application is the segment for Toolroom Management.

APPENDIX G

DMDS DATA ELEMENTS

1. ACCEPTANCE DATE--date when a specific aircraft is registered on the Navy inventory for the first time.

2. ACTION DATE--the action date is the date of the last "workload transaction code" taken from the WIP file of the MIS/INAS system. It is computer generated.

3. ACTION JULIAN DATE--date that the NR form is filled out. Taken from the workload calendar.

4. ACTION ORGANIZATION--the maintenance activity that actually performs the maintenance action.

5. ACTION TAKEN CODE--describes work done on component or equipment.

6. AIRCRAFT STATUS--a classification of the employment or condition of an aircraft. Also indicates when an aircraft leaves or returns to the active Navy aircraft inventory.

7. BUREAU/SERIAL NUMBER (BUNO)--a bureau numberis the registration number of an aircraft. A serial number identifies a specific GSE item or engine.

8. CALENDAR DAYS IN-PROCESS--the calendar days an aircraft underwent processing in the NARF. Calculated from induction day to completion day, including non-working days. It is computer generated.

9. CARD TYPE--card types are those cards/forms used as a data source.

10. CHANGE CODE--defines whether aircraft, engine or F/E units are inducted into rework and what type of documentation accompanied the unit.

11. COMPLETION DATE--completion Julian date that aircraft completes the depot cycle.

12. COMPONENT IDENTITY NUMBER (CIN)--CIN is part of the MDR control group identifying a component and its sequencing and routing. It is computer printed from MDR coding.

13. CORROSION TYPE CODE (CTC)--CTC describes simple types of corrosion found on aircraft, engines and F/E.

14. DIRECT REPLACED MATERIAL COST--the cost ofmaterial purchased for a designated aircraft. The material is not stocked and its purchase is not intended to establish an inventory; only to meet the specific demand.

15. EXTENT OF CORROSION (EOC)--EOC codes the depth of repair taken to remove the corrosion and return the unit/item to serviceable condition.

16. FIX MAN-HOURS--total man-hours expended on aircraft during depot cycle. This is computer generated.

17. FLIGHT HOURS SINCE ACCEPTANCE--total flight hours accumulated on aircraft since acceptance into the Navy inventory.

18. FLIGHT HOURS SINCE LAST DEPOT MAINTENANCE--flight hours accumulated on the aircraft since the last induction for depot level maintenance.

19. INCOMING CONDITION CODE (ICC)--ICC's are assigned to each SRC component upon disassembly in the responsible shop. ICC's will also be assigned to items processed for corrosion treatment.

20. INDUCTION DATE--date that an aircraft is inducted into a depot level maintenance program.

21. JOB CONTROL NUMBER--10 or 12 characteralphanumeric number that is designed to assist in the control of work done by an activity.

22. LINK NUMBER--a computer generated control number used to identify each item for which OPDOC's are prepared.

23. MAINTENANCE LEVEL--maintenance tasks and activities are divided into three levels to maximize the common standards that can be applied to military maintenance requirements. This is computer generated.

24. MALFUNCTION CODE (MAL)--code used to describe malfunction which has caused the unit to be removed. The code assigned by the repairing mechanic will reflect the actual defect encountered and repaired.

25. MAN-HOURS (MH)--total number of direct man-hours expended in performing a maintenance action. Includes removal, repair and installation times, as applicable.

26. MAN-HOUR CATEGORY CODE (MHC)--MHC's are coded on the MDR and categorize the types of tasks performed at the operation line level. This is computer generated.

27. MANUFACTURER'S CODE--federal supply catalog code used to uniquely identify individual manufacturers. This is computer generated.

28. MANFACTURER'S PART NUMBER (PART NUMBER)--this is a manufacturer's assigned part number that is applied to a part for identification purposes.

29. MDR CONTROL CODE (MDRCC)--a code which identifies the major work program and the model of aircraft or engine in the aircraft and engine program and the family identification code in the F/E program.

30. METER/TIME/CYCLE CODE (METER CODE - MC)--MC prefix codes most adequately describe the type of in-service usage of the item.

31. METER READING--meter reading most adequately describes the number of operating cycles or time on the equipment during service and complements the meter code.

32. MILSTRIP DOCUMENT SERIAL NUMBER--a combination of Julian date/serial number that uniquely identifies the supply document under which a replacement part was ordered. This is computer generated.

33. MISCELLANEOUS MAN-HOURS--man-hours that are transacted from labor lines on the MDR and are not concerned with TDC, routine, or rework/repairs. This is computer generated.

34. MONTHS SINCE LAST DEPOT--total number of months since last depot maintenance as recorded in aircraft logbook.

35. PAR NUMBER--Progressive Aircraft Rework (PAR) cycles that have been completed to date. (SDLM cycles)

36. PARTS COST--costs of repair parts required to make equipment serviceable. Used to report costs of GSE and VAST items when a DOP receives support from another activity in accomplishing the rework of the item.

37. PART NAME--the noun name of a component as listed in the IPB.

38. QUANTITY--the number of items being reported on the form.

39. ROUTINE MAN-HOURS--man-hours required to perform routine maintenance on an aircraft. This is computer generated.

40. SCHEDULED INDUCTION FISCAL YEAR--date aircraft is scheduled for induction for workload planning purposes.

41. SCHEDULED INDUCTION WORK DAY--scheduled day during the workweek that an item is to be inducted into a depot maintenance program. This is also used for workload planning.

42. SCHEDULED REMOVAL COMPONENT (SRC)--a component that has a scheduled remove and replace requirement based on a finite number of flight hours, operating hours, or operating cycles.

43. SEQUENCE NUMBER--a number that is a part of a series of numbers that has been assigned for scheduling. The number is locally generated and is used for unique identification.

44. SERIAL NUMBER (mandatory only for GSE/VAST)--a number assigned to a component for unique identification.

45. SORT CONTROL--provides a means of sorting data by the type of action taken within the NARF. This is computer generated.

46. STATUS DATE--signifies a change of aircraft status on the date received.

47. SUPPLEMENTARY RECORD CODE--data that is identified as being received after the end item has been reported. This is computer generated.

48. TECHNICAL DIRECTIVE MAN-HOURS--man-hours that are transacted from labor lines on the MDR and are primarily concerned with formal technical directive compliance. This is computer generated.

49. TURN-AROUND TIME (TAT)--the total time involved in reworking a component. This is generated by the computer using the WIP file.

50. TYPE/MODEL/SERIES NAME (TMS)--identifies the end item code for aircraft, missiles, or engines.

51. WORKDAYS IN PROCESS (WIP)--the number of workdays from induction to completion of the aircraft.

52. WORKLOAD TYPE CODE--the generalized type of equipment the work will involve, i.e., aircraft, engine, and VAST.

53. WORKLOAD PROGRAM/SUBPROGRAM--program designation within the NARF cost control system for planning and controlling workload, funding, man-hour allocations and ceilings, and integrating them into the overall NARF decision process.

54. WORK UNIT CODE (WUC)--the WUC is used to identify the system, subsystem, assembly, and component or part of the end item.

55. WORK UNIT and TYPE EQUIPMENT CHANGE CODE--a code used to add, change, or delete data items from the DMDS master file.

LIST OF REFERENCES

1. Webster's New Collegiate Dictionary, G. & C. Merriam, Co., 1979.

2. National Bureau of Standards Publication 511-1, Economic Effects of Metallic Corrosion in the United States, by L.H. Bennett, and others, May 1978.

3. National Bureau of Standards Special Publication 511-2, Economic Effects of Metallic Corrosion in the United States, Battelle Columbus Laboratories, May 1978.

4. Naval Safety Center Report 00, Corrosion Related Mishaps, 15 August 1985.

5. The Depot Maintenance Data System, Naval Air Systems Command Presentation Outline, 24 July 1985.

6. Commander, Naval Air Systems Command, Standard Depot Level Maintenance Specification for Navy Model S-3A, US-3A, KS-3A Aircraft, December 1983.

7. Personal interview between Mr. Charles Maduell, Naval Engineering Support Office Code (311), Naval Air Rework Facility Alameda, California, and Steven L. Hanson, Age Exploration Program Interview, 19 July 1985.

8. Naval Air Rework Facility Alameda, California, Standard Procedure Instruction 4730.15, Structural Sampling Program, 17 March 1977.

9. VSE Corporation Memorandum: to S-3 Weapon System Engineering Division Head (310), Subject: S-3 SSI Review Preliminary Findings, 15 July 1985.

10. Commander, Naval Air Systems Command, Standard Depot Level Maintenance Specification for Navy Model S-3A, US-3A, KS-3A Aircraft, 1 December 1976.

11. Personal interview between Mr. Larry Crow (Code 212), Naval Air Rework Facility, Alameda, California, and Mark E. Karr, MIS/INAS Operations Interview, 19 August 1985.

12. Personal interview between Mr. Sam Shell, Naval Air Rework Facility, Cherry Point, North Carolina, and Steven L. Hanson, Documentation of Work Content for Norm Development and Engineering Analysis presentation, 8 August 1985.

13. Naval Aviation Logistics Center, Depot Maintenance Data Collection System Data Dictionary Reference Manual.

14. Personal interview between Mr. Sam Brightbill, Naval Air Rework Facility, Norfolk, Virginia, and the authors, DMDS Operational Interview, 21 August 1985.

15. Personal interview between Mr. Warren Savage, DMDS Program Manager, Naval Air Systems Command, Washington, DC, and the authors, DMDS Overview Interview, 19 August 1985.

INITIAL DISTRIBUTION LIST

		No. Copies
1.	Defense Technical Information Center Cameron Station Alexandria, Virginia 22304-6145	2
2.	Library, Code 0142 Naval Postgraduate School Monterey, California 93943-5002	2
3.	Professor Willis R. Greer, Jr., Code 54Gk Department of Administrative Sciences Naval Postgraduate School Monterey, California 93943-5004	1
4.	Professor John W. Creighton, Code 54Cf Department of Administrative Sciences Naval Postgraduate School Monterey, California 93943-5004	10
5.	Professor Alan W. McMasters, Code 54Mg Department of Administrative Sciences Naval Postgraduate School Monterey, California 93943-5004	1
6.	Defense Logistics Studies Information Exchange U.S. Army Logistics Management Center Fort Lee, Virginia 23801	1
7.	Casimir E. Lawler Head, S-3 Engineering Division, Code 310 Naval Air Rework Facility Naval Air Station Alameda, California 94501-5021	10
8.	Robert D. Kimsey Head, Missile Test Branch, Code 1032 Pacific Missile Test Center Point Mugu, California 93042-5000	1
9.	LCDR Steven L. Hanson Department of the Navy Naval Supply Systems Command, NSUP-0312A Washington, DC 20361	2
10.	Mark E. Karr 5224 Albright Drive Virginia Beach, Virginia 23464	1

11. Research Administration Office 1
Code 012
Naval Postgraduate School
Monterey, CA 93943

216627

Thesis
H20463
c.1

Hanson
An analysis of S-3
SDLM corrosion docu-
mentation procedures.

216627

Thesis
H20463
c.1

Hanson
An analysis of S-3
SDLM corrosion docu-
mentation procedures.

AMERICAN BINDERIES

thesH20463
An analysis of S-3 SDLM corrosion docume
3 2768 000 65966 8
DUDLEY KNOX LIBRARY